Building Research Establishment Digest

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June 1978

Cavity barriers and fire stops : Part 1

Because of a number of incidents in which the spread of fire was apparently assisted by the presence of cavities within structural elements and roof spaces, the Building Regulations 1976 introduced a requirement for the provision of cavity barriers. This digest, which is published in two parts, discusses the practical problems involved in choosing appropriate materials and considers the methods of fabricating and erecting cavity barriers and fire stops in a number of typical situations. The details are offered as a starting point for the initial design and should not be regarded as having a 'deemed to satisfy' status.

Smoke and flames spread through hidden voids in construction, particularly between suspended ceilings and floors or roofs. Because this spread of fire is concealed it presents a more insidious danger than do obvious visible weaknesses.

It is with the object of restricting this unseen spread of fire that a requirement for cavity barriers has been introduced into the Building Regulations 1976.

The application of Building Regulations is a matter for local authorities who have the responsibility for their administration. This digest does not purport to be an authoritative interpretation of the legal requirements of the regulations but has been produced as an aid to understanding their technical intention and suggests some solutions to the problem based on materials at present in general use. The solutions given are considered practical but have not all been tested in accordance with the conditions of BS 476 : Part 8 : 1972.

Table 1 Maximum distance between cavity barriers

Location of cavity	Purpose group of building or compartment	Class of exposed surface within the cavity, excluding pipes, cables and conduits	Maximum distance
Between a roof and a ceiling	I and flats or maisonettes within III	Any	No Limit
	II and III except flats and maisonettes	Any	15 m with area limited to 100 m² *
	Any other	Any	20 m
** Other than between a roof and a ceiling	Any	Class O	20 m
		Other than Class O	8 m

* Area of void, NOT surface area of barrier

** eg between floor and ceiling and in walls

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Technical enquiries arising from this Digest should be directed to Building Research Advisory Service at the above address.

Definitions

Fire-Stop A seal to close an imperfection of fit between components or construction so as to restrict penetration of smoke or flame through such imperfections; Fig 1.

Cavity Barrier Construction provided to close or divide a cavity against penetration of smoke or flame including construction provided for another purpose providing it conforms to the criteria for cavity barriers.

Small Cavity Barrier A barrier across a void in which a square with 1 m sides cannot be accommodated; Figs 2 and 3.

Large Cavity Barrier A barrier across a void in which a square having sides of 1 m can be accommodated; Fig 4.

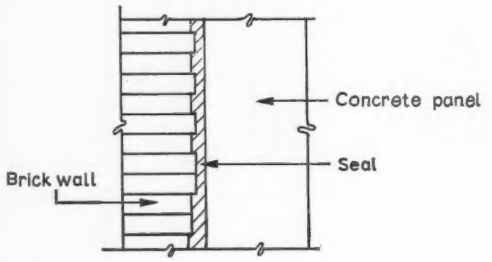


Fig 1 Fire stop

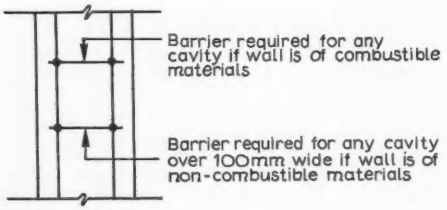

Barrier required for any cavity if wall is of combustible materials
Barrier required for any cavity over 100mm wide if wall is of non-combustible materials

Fig 2 Small barrier: walls

NOTIONAL SECTIONS

Fig 3 Small barrier: roof, floor or ceiling voids

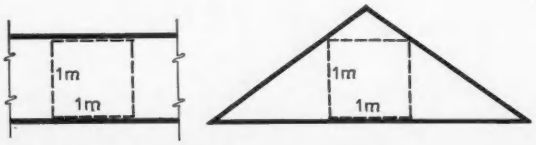


Fig 4 Large barrier: roof, floor or ceiling voids

Design criteria

Fire stops should be non-combustible.

Cavity barriers should, depending on the construction, be positioned in a cavity as follows:
a) in the same plane as elements required to have fire resistance;
b) around the perimeter of elements required to have fire resistance, and around any openings therein;
c) at intervals to restrict the area of the cavity (see Table 1).

Small cavity barriers should be constructed of any of the following materials:
asbestos building or insulation board (but not asbestos cement sheet) not less than 9 mm thick;
plasterboard not less than 12·5 mm thick;
steel not less than 3 mm thick;
timber not less than 38 mm thick;
wire reinforced mineral wool blanket or mineral fibre building or insulation board not less than 50 mm thick;
cement mortar, plaster or other non-combustible material not less than 25 mm thick;
or may be constructed so as to provide fire resistance as specified for larger cavity barriers.
Large cavity barriers should satisfy the criteria of BS 476: Part 8: 1972

Stability	30 mins
Integrity	30 mins
Insulation	15 mins

Design requirements

If the construction of a building makes it necessary to provide cavity barriers the design should fulfil four basic requirements.

Requirement 1

Smoke and flames must be prevented from passing from any cavity in an element of building directly into a room or another cavity. To achieve this, the perimeters of such elements and of any openings in them should be closed with a suitable material. No cavity in one element should communicate with any cavity in another element. This may already be provided by the construction, but if not, then a cavity barrier must be provided; Fig 5.

Exceptions: Conventional brick/block walls. Any other non-combustible cavity walls provided the conditions illustrated in Fig 6 are met.

Requirement 2

To prevent smoke and flame from by-passing any elements that are required to have fire resistance. Any cavity crossing the edges/ends of an element required to have fire resistance, such as a floor or

wall, should have a cavity barrier in the same plane as the element; Fig 5.

Exceptions: Cavities in conventional brick walls and other non-combustible cavity walls provided the conditions illustrated in Fig 6 are met. Cavities below suspended ground floors. Cavities in floors and roofs if the cavities extend throughout the building or compartment and the ceiling is not readily demountable and satisfies the special fire resistance requirement as well as flame spread specifications. Roof cavities of Purpose Group I buildings except that in houses of three or more storeys the ceiling over the staircase enclosure will require a fire resistance of not less than half-an-hour; Fig 7.

Requirement 3

To prevent smoke and flames travelling long distances in cavities. This is accomplished by sub-dividing the cavity with cavity barriers positioned so that the maximum distances between cavity barriers are appropriate to the location of each cavity and to the flame spread rating for the internal surfaces see Table 1.

Exceptions: Cavities in conventional brick/block walls. Cavities below suspended ground floors, if the cavities are less than 1 m in height, or are not accessible. Cavities between roofing sheets, if the sheets are non-combustible and the cavities are filled with insulating materials having a surface spread of flame rating not less than Class 1; Fig 8.

Requirement 4

To maintain the integrity of any structure which is designed to act as a barrier to the passage of smoke or flame, including a cavity barrier, by preventing smoke or flame from passing through gaps resulting from imperfections of fit arising at the time of building, or distortion in the event of a fire, or where openings are provided for services to pass through.

This can be achieved in the following ways:

barriers should be firmly fixed and tightly fitted (or fire-stopped) and should remain so during the life of the building and be effective in the event of a fire;

openings in barriers should be fitted with fire shutters which will operate automatically in the event of a fire, or with fire-resisting doors;

ducts, where they pass through barriers, should be fire-stopped between barrier and duct and should also be fitted with fire shutters unless they are continuous and constructed of mild steel.

openings for services should be kept as few in number and as small as possible, and be fire-stopped.

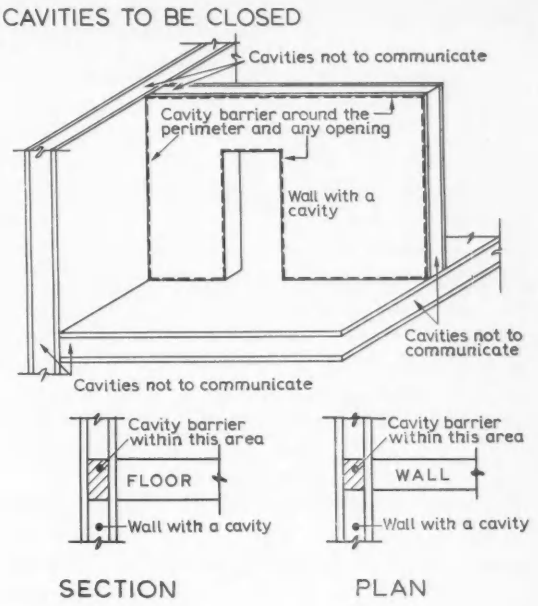


Fig 5 Cavity barriers

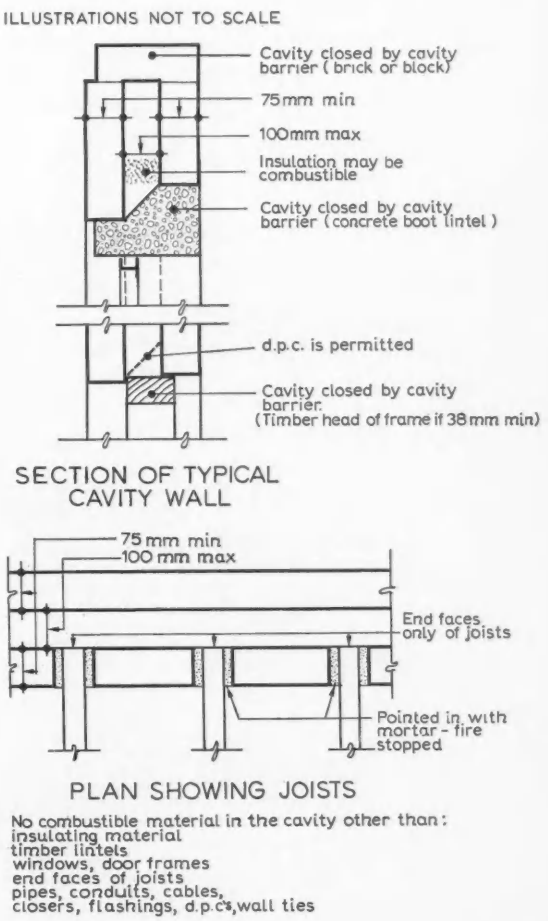

ILLUSTRATIONS NOT TO SCALE
Cavity closed by cavity barrier (brick or block)
75mm min
100mm max
Insulation may be combustible
Cavity closed by cavity barrier (concrete boot lintel)
d.p.c. is permitted
Cavity closed by cavity barrier.
(Timber head of frame if 38mm min)
SECTION OF TYPICAL CAVITY WALL
75 mm min
100 mm max
End faces only of joists
Pointed in with mortar - fire stopped
PLAN SHOWING JOISTS
No combustible material in the cavity other than:
insulating material
timber lintels
windows, door frames
end faces of joists
pipes, conduits, cables,
closers, flashings, d.p.c's, wall ties

Fig 6 Requirements for non-combustible cavity walls

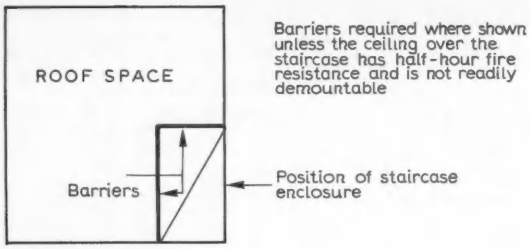

ROOF SPACE
Barriers required where shown unless the ceiling over the staircase has half-hour fire resistance and is not readily demountable
Barriers
Position of staircase enclosure

Fig 7 Roof plan: house of three or more storeys

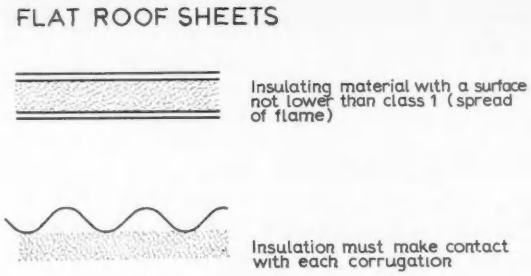
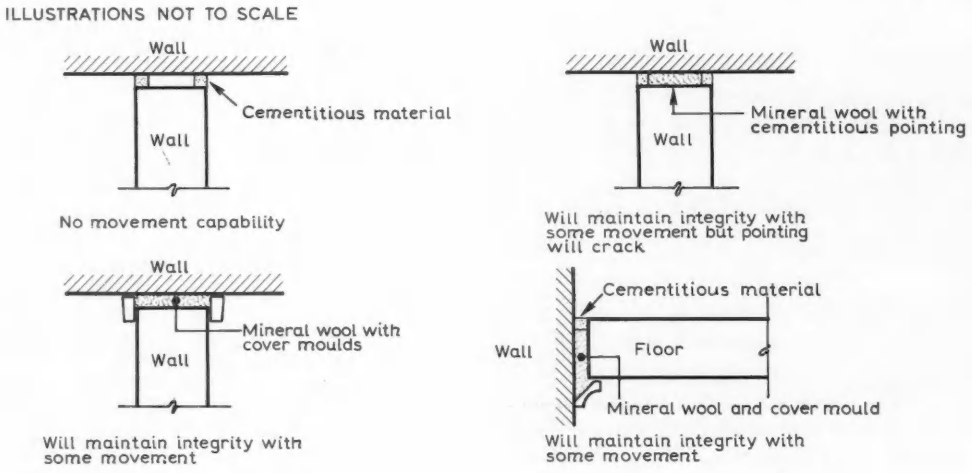
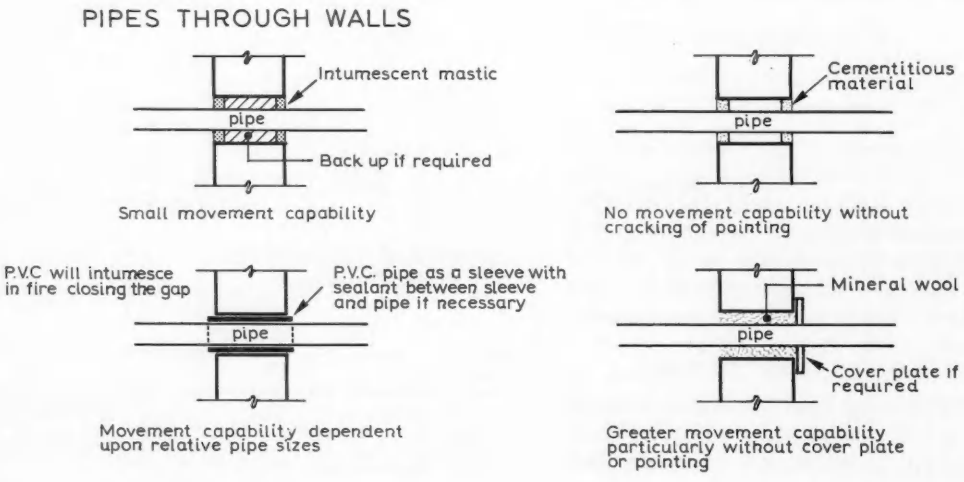

FLAT ROOF SHEETS
Insulating material with a surface not lower than class 1 (spread of flame)
Insulation must make contact with each corrugation

Fig 8 Non-combustible roof sheeting




PIPES THROUGH WALLS
Intumescent mastic
pipe
Back up if required
Small movement capability
Cementitious material
pipe
No movement capability without cracking of pointing
P.V.C will intumesce in fire closing the gap
P.V.C. pipe as a sleeve with sealant between sleeve and pipe if necessary
pipe
Movement capability dependent upon relative pipe sizes
Mineral wool
pipe
Cover plate if required
Greater movement capability particularly without cover plate or pointing

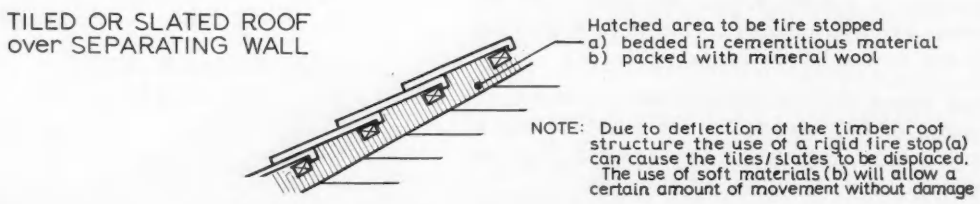

TILED OR SLATED ROOF over SEPARATING WALL
Hatched area to be fire stopped
a) bedded in cementitious material
b) packed with mineral wool
NOTE: Due to deflection of the timber roof structure the use of a rigid fire stop (a) can cause the tiles/slates to be displaced. The use of soft materials (b) will allow a certain amount of movement without damage

Fig 9 Fire-stopping

Solutions

The regulations divide cavity barriers into categories based on their size using the accommodation of a square with 1 m sides as a criterion. For the sake of convenience these are described in this digest as large or small barriers. All large barriers are required to satisfy the fire resistance requirements defined in the regulations for at least half an hour. However, most cavity barriers are likely to be less than 1 m in depth and consequently fall into the category of small barriers.

It is important for all barriers to maintain their integrity during the life of the building and in a fire taking account of possible movements and deflections.

Fire-stopping

Situations where fire-stopping is likely to be required include junctions between the following, unless they are properly bonded together:

Separating wall—external wall

Separating wall—compartment wall

Compartment wall—external wall

Compartment wall—compartment floor

Compartment floor—separating wall

Compartment floor—external wall

The openings around pipes passing through elements of structure require to be fire-stopped.

Materials suitable for fire-stopping

Mineral wool, mineral fibre board or insulation board;
Cementitious materials;
Preformed blocks of fine silica fibre with inorganic binders;
Intumescent mastic;
PVC pipe (as a sleeve for small pipes);
Asbestos rope for caulking (this material will require safety precautions to be observed).

The intumescent mastic and the PVC pipe do not comply with the requirement of non-combustibility; however, they may be satisfactory materials for many situations and it is considered that relaxation might be appropriate in some circumstances.

Some typical solutions are shown in Fig 9.

Cavity barriers

The suggested proposals for the design of barriers deal with small and large cavity barriers separately. However, the small barrier, if greater than a certain depth depending upon the nature of the material (see Fig 10) will require the same design considerations as a large barrier. The following typical situations are considered:

Roof/ceiling (flat and pitched) – large and small barriers;
floor/ceiling void – large and small barriers;
below ground floor – small barrier (if access provided);
below ground floor – large barrier (if over 1 m)
walls – small barrier.

Small barriers

The traditional type of brick/block cavity walls will not usually be required to have cavity barriers specially provided within them. If constructed in accordance with traditional good practice, houses will be unlikely to need special provision because the construction will usually fulfil the requirements shown in Fig 6.

Cavity walls of brick/block where the cavity is over 100 mm and any width in walls of combustible material will require cavity barriers in accordance with the regulations:
to prevent one cavity communicating with another;
to prevent an element required to have fire resistance being by-passed;
to limit the area of the cavity, see Table 1.

Materials suitable for differing sizes of small barriers

Suitable materials are suggested for small barriers in Fig 10; fire-stopping may also be required if the barrier is not tightly fitted.

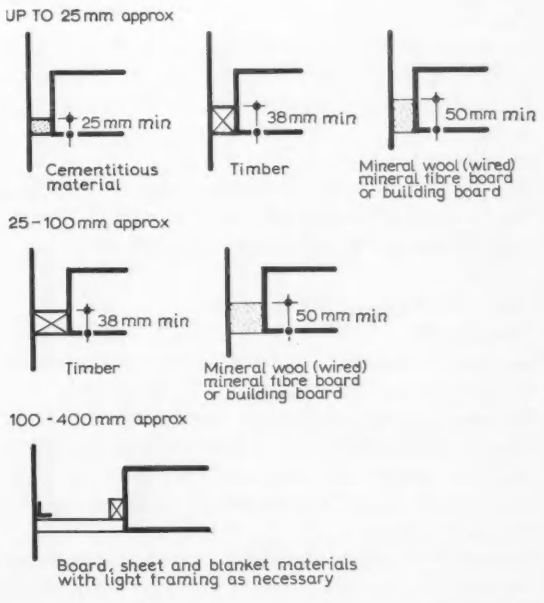

UP TO 25mm approx
25mm min
Cementitious material
38mm min
Timber
50mm min
Mineral wool (wired) mineral fibre board or building board
25-100mm approx
38mm min
Timber
50mm min
Mineral wool (wired) mineral fibre board or building board
100 - 400mm approx
Board, sheet and blanket materials with light framing as necessary
450mm +
Solutions similar to those shown in Figs 15-23 for Large Cavity Barriers can be used

Fig 10 Small cavity barriers: diagrammatic wall to wall situations

Large barriers

Positions where barriers may occur:
where there is a supporting wall/partition under;
where there is no supporting wall/partition under;
parallel to beams or trusses;
at right angles to beams or trusses;
solid construction at sides;
void at sides.

Fixings

A cavity barrier should be fixed in such a manner that it is not rendered ineffective by movement of the building due to shrinkage or thermal changes. Where subsidence is likely to occur, special provisions will need to be taken to maintain integrity. Where a tight fixing cannot be made between a barrier and the structure, the gaps should be fire-stopped.

Movement to be allowed for
Normal shrinkage and thermal movement;
Considerable movement of the suspended ceiling in fire;
General movement of the structure in fire and special conditions of subsidence (approximately 25 mm assumed for the purpose of the solutions in Figs 15 to 23).

Materials suitable for cavity barriers

Rigid
plasterboard;
asbestos insulation board (or substitute materials);
vermiculite board;
treated plywood.
Semi-rigid
Expanded metal lath of various types and a soft iron wire mesh coated with baked clay, sprayed with cement/vermiculite, limpet mineral fibre or perlited plaster.
Flexible
50 mm wire reinforced mineral wool or asbestos woven cloth (the latter will retain its integrity but is unlikely to meet the insulation criterion).

Support framing for barriers

The quantity and strength of framing required will vary depending on the size and precise circumstances in each case but suitable materials would be:
Exposed framing: proprietary slotted angle systems or mild steel angles. Any protection and insulation required could be obtained by painting with intumescent paste if not already covered by the sprayed material.
Concealed framing: softwood framing with sheet materials or metal channel framing with sheet materials.

Design and sequence of operations

Where possible the cavity barriers should be fixed to beams or trusses, or placed over partition/walls, even if this means spacing them at less than the maximum allowed under the Regulations. If services are grouped in certain areas it will make the erection of the cavity barrier simpler and allow the bulk of the work to be carried out independently of services installation. However, the barrier cannot be completed until all services are installed.
The cavity barrier will often need to be erected before the suspended ceiling. Where there is no partition/wall below, it may be an advantage to have the main ceiling runners fixed to provide a reference from which to work. In order that the cavity barrier can be inspected when completed, it may be necessary to either leave adjacent ceiling tiles out, or at least to be able to remove them conveniently.
In many cases it would seem desirable that the ceiling subcontractors also fix this type of cavity barrier.

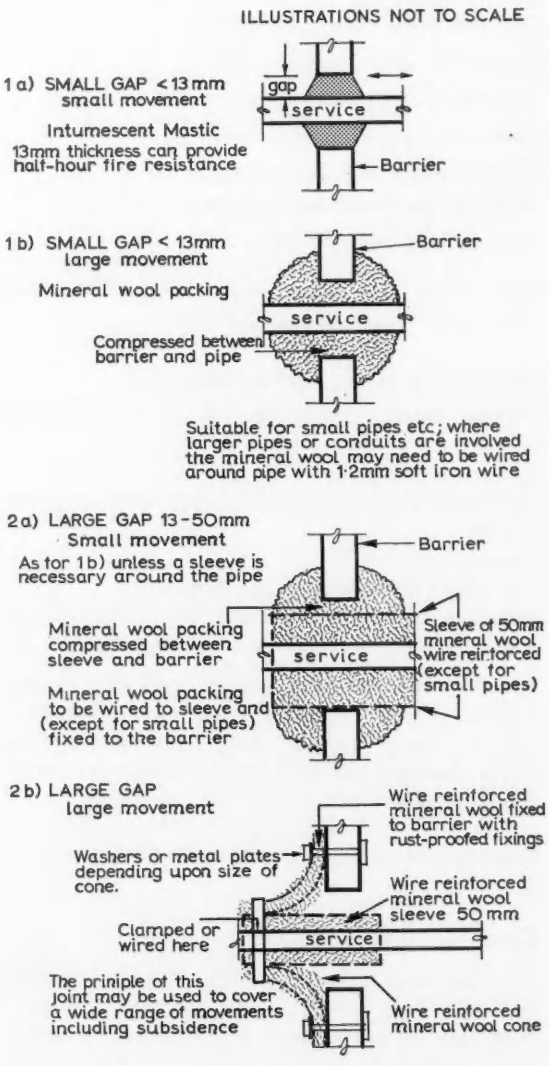


Fig 11 Penetration of cavity barrier by pipes, cables etc: rigid barrier

Penetration of cavity barriers by pipes, cables and conduits

Fire-stopping must not impede the relative movements of the pipe, cable, or conduit, and the barrier.

Rigid barrier (see Fig 11)

Small gap (13 mm)

(a) Small movement
Specially formulated intumescent mastics

(b) Large movement
Pack mineral wool around pipe etc.

Large gap (13-60 mm)

(a) Small movement
Pack mineral wool around pipe etc, provide sleeve around pipe if necessary.

(b) Large movement
Provide a sleeve around the pipe etc, and a cone of wired mineral wool 50 mm thick fixed to barrier and clipped around pipe etc.

Semi-rigid barrier (see Fig 12)

Additional fire-stopping may not be required if all pipes, conduits, etc, are in position when the spraying takes place.

When ribbed expanded metal lath (with or without synthetic coating) is used, an extra loose split collar of lighter gauge expanded metal lath is fitted around pipe etc, and wired to main area of ribbed lath.

For pipes etc, added later, either the area should be re-sprayed or mineral wool packing could be used.

If very large movement is expected, a sleeve of mineral wool should be wired around the pipe and a cone of mineral wool 50 mm thick fixed to barrier and clipped around pipe.

Flexible barrier (see Fig 13)

Cut wired mineral wool barrier around pipe etc, and wire in place, sleeve as necessary.

Penetration of cavity barrier by beams or trusses (Fig 14)

Solid beams Treatment similar to that used for the perimeter in each particular case will usually be satisfactory.

Lattice trusses Sprayed materials on metal lath provide an easy solution unless large movement is expected. Where large movement is likely it may be necessary to frame around the truss and use wired mineral wool as a fire-stop securely fixed to each side of the barrier.

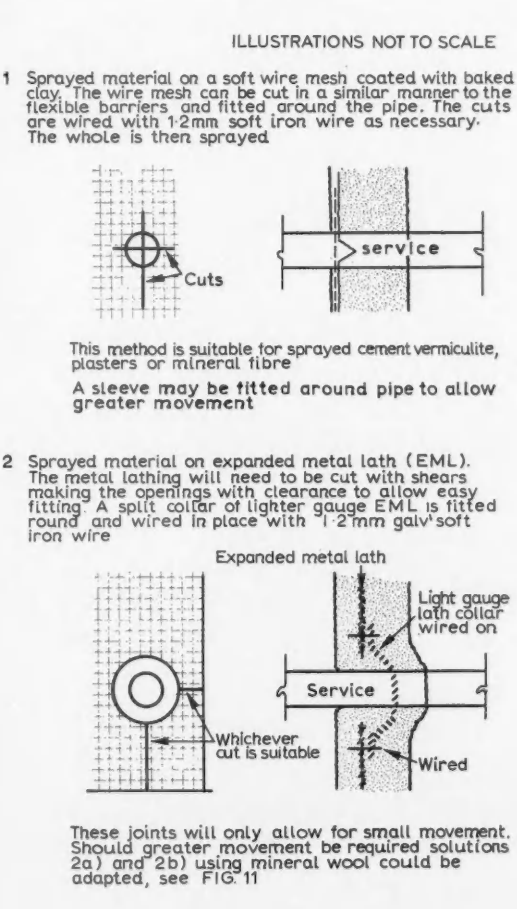

ILLUSTRATIONS NOT TO SCALE
1 Sprayed material on a soft wire mesh coated with baked clay. The wire mesh can be cut in a similar manner to the flexible barriers and fitted around the pipe. The cuts are wired with 1·2mm soft iron wire as necessary. The whole is then sprayed
Cuts
service
This method is suitable for sprayed cement vermiculite, plasters or mineral fibre
A sleeve may be fitted around pipe to allow greater movement
2 Sprayed material on expanded metal lath (EML). The metal lathing will need to be cut with shears making the openings with clearance to allow easy fitting. A split collar of lighter gauge EML is fitted round and wired in place with 1·2mm galv soft iron wire
Expanded metal lath
Light gauge lath collar wired on
Service
Whichever cut is suitable
Wired
These joints will only allow for small movement. Should greater movement be required solutions 2a) and 2b) using mineral wool could be adapted, see FIG 11

Fig 12 Penetration of cavity barrier by pipes, cables etc: semi-rigid barrier

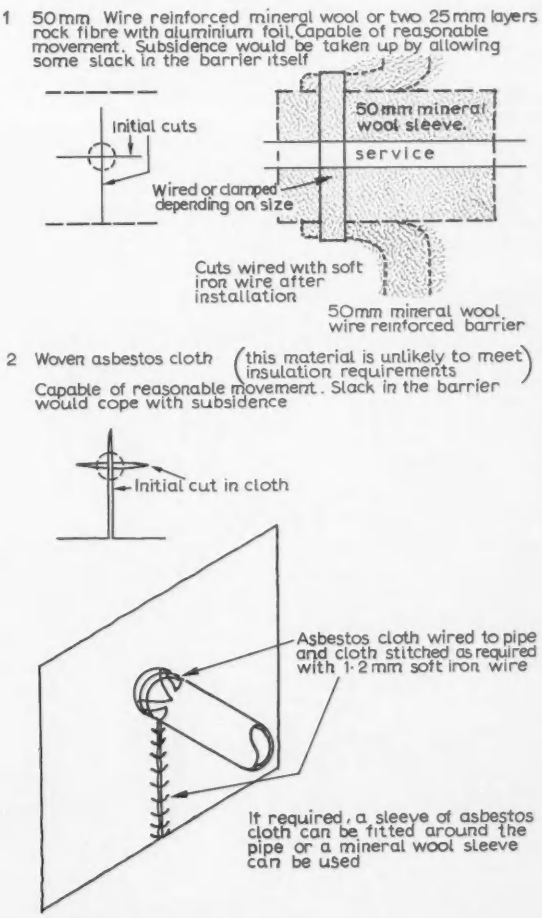

1 50mm Wire reinforced mineral wool or two 25mm layers rock fibre with aluminium foil. Capable of reasonable movement. Subsidence would be taken up by allowing some slack in the barrier itself
Initial cuts
50mm mineral wool sleeve.
service
Wired or clamped depending on size
Cuts wired with soft iron wire after installation
50mm mineral wool wire reinforced barrier
2 Woven asbestos cloth (this material is unlikely to meet insulation requirements)
Capable of reasonable movement. Slack in the barrier would cope with subsidence
Initial cut in cloth
Asbestos cloth wired to pipe and cloth stitched as required with 1·2mm soft iron wire
If required, a sleeve of asbestos cloth can be fitted around the pipe or a mineral wool sleeve can be used

Fig 13 Penetration of cavity barrier by pipes, cables etc: flexible barrier

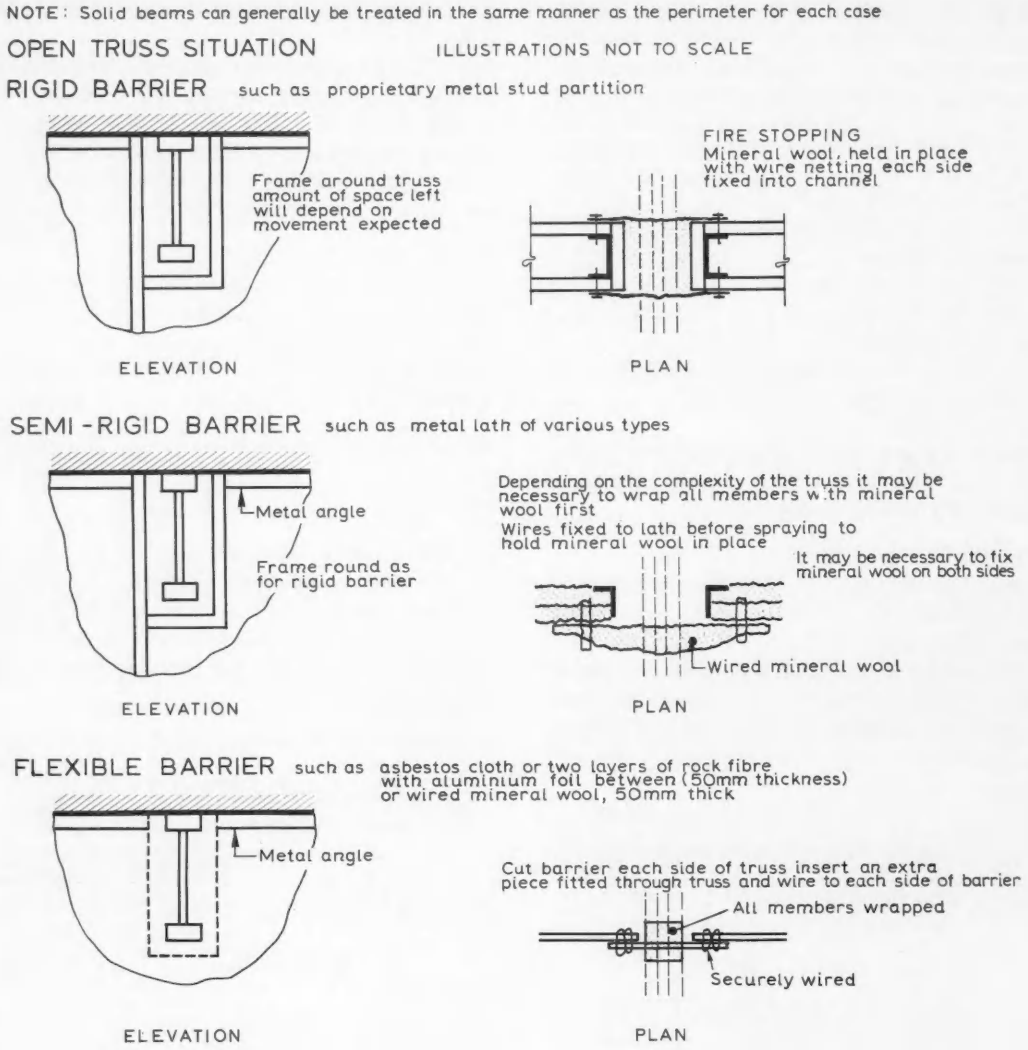

NOTE: Solid beams can generally be treated in the same manner as the perimeter for each case
OPEN TRUSS SITUATION
ILLUSTRATIONS NOT TO SCALE
RIGID BARRIER such as proprietary metal stud partition
Frame around truss amount of space left will depend on movement expected
FIRE STOPPING
Mineral wool, held in place with wire netting each side fixed into channel
ELEVATION
PLAN
SEMI-RIGID BARRIER such as metal lath of various types
Metal angle
Frame round as for rigid barrier
Depending on the complexity of the truss it may be necessary to wrap all members with mineral wool first
Wires fixed to lath before spraying to hold mineral wool in place
It may be necessary to fix mineral wool on both sides
Wired mineral wool
ELEVATION
PLAN
FLEXIBLE BARRIER such as asbestos cloth or two layers of rock fibre with aluminium foil between (50mm thickness) or wired mineral wool, 50mm thick
Metal angle
Cut barrier each side of truss insert an extra piece fitted through truss and wire to each side of barrier
All members wrapped
Securely wired
ELEVATION
PLAN

Fig 14 Penetration of cavity barrier by beams and trusses

Attention is drawn to the advice given in the interim statement of the advisory committee on asbestos set up by the Health and Safety Executive on the precautions to be adopted when using asbestos.

Department of the Environment **Building Research Establishment**

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